Optional Practice for Writig net ionic equations and solubility practice with answers

The following are the solubility rules for common ionic solids. If there two rules appear to contradict each other, the preceding rule takes precedence.

1. Salts containing Group I elements (Li^+, Na^+, K^+, Cs^+, Rb^+) are soluble*. Salts containing the ammonium ion (NH_4^+) are also soluble.
2. Salts containing nitrate ion (NO_3^-), per chlorate (ClO_4^-), chlorate ions (ClO_3^-) as well as acetate ion ($C_2H_3O_2^-$) are soluble.
3. Salts containing Cl^-, Br^-, or I^- are generally soluble. Important exceptions to this rule are halide salts of Ag^+, Pb^{2+}, and $(Hg_2)^{2+}$. Thus, AgCl, $PbBr_2$, and Hg_2Cl_2 are insoluble.
4. Most silver salts are insoluble. $AgNO_3$ and $Ag(C_2H_3O_2)$ are common soluble salts of silver; virtually all others are insoluble.
5. Most sulfate salts are soluble. Important exceptions to this rule include $CaSO_4$, $BaSO_4$, $PbSO_4$, Ag_2SO_4 and $SrSO_4$.
6. Most hydroxide salts are only slightly soluble. Hydroxide salts of Group I elements are soluble. Hydroxide salts of Group II elements (Ca, Sr, and Ba) are slightly soluble. Hydroxide salts of transition metals and Al^{3+} are insoluble. Thus, $Fe(OH)_3$, $Al(OH)_3$, $Co(OH)_2$ are not soluble.
7. Most sulfides of transition metals are highly insoluble, including CdS, FeS, ZnS, and Ag_2S. Arsenic, antimony, bismuth, and lead sulfides are also insoluble.
8. Carbonates are frequently insoluble. Group II carbonates ($CaCO_3$, $SrCO_3$, and $BaCO_3$) are insoluble, as are $FeCO_3$ and $PbCO_3$.
9. Chromates are frequently insoluble. Examples include $PbCrO_4$ and $BaCrO_4$.
10. Phosphates such as $Ca_3(PO_4)_2$ and Ag_3PO_4 are frequently insoluble.
11. Fluorides such as BaF_2, MgF_2, and PbF_2 are frequently insoluble.

*There are few exceptions to this rule.

A:

Answer the solubility questions and provide supporting evidence for you answerd

1. Is $FeCO_3$ soluble?
2. Does ClO_4^- tend to form a precipitate?.
3. Which of these substances is likely to form a precipitate?

a) $CaSO_4$ b) table salt c) AgBr

4. Predict whether a precipitate will form as a result of this reaction:

$2AgNO_3+Na_2S \rightarrow Ag_2S+2NaNO_3$

5. Predict if a precipitate will form as a result of this reaction:

$2NaOH+K_2CrO_4 \rightarrow KOH+Na_2CrO_4$

B:

All reactants are standard solutions (25^{o}C 1.0M) unless other side noted

1. Barium Bromide reacts with hydrogen Sulfide (sulfuric acid)	7. Potassium Nitrate and Lithium acetated solutions are mixed	13. Baking powder (sodium carbonate) is mixed with barium chloride
2. Zinc metal is added to silver nitrate	8. Zinc (II) nitrate and hydrogen sulfide are combined	14 To neutralize excess Drano (sodium hydroxide) used to unclog a shower drain hydrochloric acid was added
3. Calcium Chloride and sodium phosphate and mixed	9. Silver(I) nitrate is titrated with hydrochloric acid to completion	Copper (II) nitrate and ammonium sulfide are combined until the blue colored copper solution turns clear
4. Bismuth hydroxide is reacted with sulfuric acid	10. Tin(II) nitrate and sulfuric acid are mixed	Lead (II) Nitrate is mixed with Potassium chromate and
5. Lead (II) Nitrate is added to hydrogen sulfide	11. Sodum chloride and potassium bromide solutions are combined	Tin(II) chloride and silver nitrate solutions are combined
6. Hydrogen bromide (hydrobromic acid) is added drop wise to solid Copper (II) Hydroxide until reaction is complete	Potassium hydroxide is neutralized with hydrochloric acid	Mercury (II) sulfate was added drop wise magnesium chlorate

Answers:

A

1. According to Rule #5, carbonates tend to be insoluble. Therefore, *$FeCO_3$ is likely to form a precipitate*.
2. This is perchlorate, which according to Rule #2 is likely to be soluble. Therefore, *it will not form a precipitate.*
3. *Letters a and c are both likely to form precipitates*.
Concerning a) $CaSO_4$, although sulfates tend to be soluble, Rule #5 indicates that calcium sulfate is an important exception to this rule.
For b), Rule #1 indicates that table salt (NaCl) is soluble because it is a salt of an alkali metal.
c) is an example of two rules contradicting each other. Rule #4 states that bromides are usually soluble, but Rule #3 states that salts of silver are insoluble. Because Rule #3 precedes Rule #4, the compound is insoluble and will form a precipitate.
4. The products of the reaction must be examined; if either of the substances formed in the reaction is insoluble, a precipitate will form.
Considering $NaNO_3$, Rule #3 states that nitrates tend to be soluble. A precipitate of this compound will not form.
Next, consider Ag_2S. According to Rule #5, that sulfides tend to be insoluble. Therefore, because of this compound, *a precipitate will form in the course of this reaction*.
5. Consider again the products of the reaction: if either is insoluble, a precipitate will form.

The first product, KOH, is an example of two rules contradicting each other. Although Rule #5 says that hydroxides tend to be insoluble, Rule #1 states that salts of alkali metal cations tend to be soluble, and Rule #1 precedes Rule #5. Therefore, this compound will not contribute to any precipitation being formed.
The second product, Na_2CrO_4, also adheres to Rule #1, which states that salts of alkali metals tend to be soluble.
Because both products are soluble, *no precipitate form as a result of this reaction.*

B:

BaBr2(aq) + H2SO4(aq) → BaSO4(s) + 2HBr(aq)
Ba2+(aq) + 2Br - (aq) + 2H+ (aq) + SO4 2- (aq) → BaSO4(s) + 2H+ (aq) + 2Br - (aq)
Ba2+(aq) + SO4 2- (aq) → BaSO4(s)

Pb(NO3)2(aq) + H2S(aq) → PbS(s) + 2HNO3(aq)
Pb2+(aq) + 2NO3 - (aq) + H2S(aq) → PbS(s) + 2H+ (aq) + 2NO3 - (aq)
Pb2+(aq) + H2S(aq) → PbS(s) + 2H+ (aq)

Zn(s) + 2AgNO3(aq) → Zn(NO3)2(aq) + 2Ag(s)
Zn(s) + 2Ag+ (aq) + 2NO3 - (aq) → Zn2+(aq) + 2NO3 - (aq) + 2Ag(s)
Zn(s) + 2Ag+ (aq) → Zn2+(aq) + 2Ag(s)

Cu(OH)2(s) + 2HBr(aq) → CuBr2(aq) + 2HOH(ℓ)
Cu(OH)2(s) + 2H+ (aq) + 2 Br(aq) → Cu2+(aq) + 2 Br(aq) + 2HOH(ℓ)
Cu(OH)2(s) + 2H+ (aq) → Cu2+(aq) + 2HOH(ℓ)

3CaCl2(aq) + 2Na3PO4(aq) → Ca3(PO4)2(s) + 6NaCl(aq)
3Ca2+(aq) + 6Cl(aq) + 6Na+(aq) + 2PO4 3- (aq) → $Ca_3(PO_4)_2$(s) + 6Na^+(aq) + 6Cl-(aq)
3Ca2+(aq) + 2PO4 3- (aq) → Ca3(PO4)2(s)

KNO3(aq) + LiC2H3O2(aq) → KC2H3O2(aq) + LiNO3(aq)
K^+(aq)+NO_3^-(aq)+Li^+(aq)+$C_2H_3O_2^-$(aq) →K^+(aq)+ $C_2H_3O_2^-$(aq) + Li+(aq)+NO_3^-(aq)
No net reaction – everything cancels

2Bi(OH)3(s) + 3H2SO4(aq) → Bi2(SO4)3(s) + 6HOH(ℓ)
2Bi(OH)3(s) + 6H+ (aq) + 3SO4 2- (aq) → 2Bi3+(aq) + 3 SO4 2- (aq) + 6HOH(ℓ)
2Bi(OH)3(s) + 6H+ (aq) → 2Bi3+(aq) + 6HOH(ℓ)

Zn(NO3)2(aq) + H2S(aq) → ZnS(s) + 2HNO3(aq)
Zn2+(aq) + 2NO3 - (aq) + H2S(aq) → ZnS(s) + 2H+ (aq) + 2NO3 - (aq)
Zn2+(aq) + H2S(aq) → ZnS(s) + 2H+ (aq)

AgNO3(aq) + HCl(aq) → AgCl(s) + HNO3(aq)
Ag+ (aq) + NO3 - (aq) + H+ (aq) + Cl(aq) → AgCl(s) + H+ (aq) + NO3 - (aq)
2NO3 - (aq) Ag+ (aq) + Cl(aq) → AgCl(s)

Pb(NO3)2(aq) + K2CrO4(aq) → PbCrO4(s) + 2KNO3(aq)
Pb2+(aq) + 2NO3 - (aq) + 2K+ (aq) + CrO4 2- (aq) → PbCrO4(s) + 2K+ (aq) +
Pb2+(aq) + CrO4 2- (aq) → PbCrO4(s)

Sr(NO3)2(aq) + H2SO4(aq) → SrSO4(s) + 2HNO3(aq)
Sr2+(aq) + 2NO3 - (aq) + 2H+ (aq) + SO4 2- (aq) → SrSO4(s) + 2H+ (aq) + 2NO3 - (aq)
AgCl(s) Sr2+(aq) + SO4 2- (aq) → SrSO4(s)

SrCl2(aq) + 2 AgNO3(aq) → Sr(NO3)2(aq) + 2 AgCl(s)
Sr2+(aq) + 2Cl(aq) + 2 Ag+ (aq) + 2NO3 - (aq) → Sr2+(aq) + 2NO3 - (aq) + 2
2Cl(aq) + 2 Ag+ (aq) → 2 AgCl(s) (or divide by two for coefficients of 1,1,1)

NaCl(aq) + KBr(aq) → NaBr(aq) + KCl(aq)
Na+ (aq)+Cl(aq)+K+ (aq)+Br(aq) →Na+ (aq)+Br(aq)+K+ (aq)+Cl(aq)
No net reaction - everything cancels

HgSO4(aq) + Mg(ClO3)2(aq) → Hg(ClO3)2(aq) + MgSO4(aq)
Hg^{2+}(aq)+SO_4^{2-}(aq)+Mg^{2+}(aq)+2ClO_3^-(aq) →Hg^{2+}(aq)+2ClO_3^- (aq)+Mg^{2+}(aq)+SO_4^{2-} (aq)
No net reaction - everything cancels

KOH(aq) + HCl(aq) → KCl(aq) + HOH(ℓ)
K + (aq) + OH(aq) + H+ (aq) + Cl(aq) → K + (aq) + Cl(aq) + HOH(ℓ)
OH(aq) + H+ (aq) → HOH(ℓ)

Na2CO3(aq) + BaCl2(aq) → BaCO3(s) + 2NaCl(aq)
2Na+ (aq) + CO3 2- (aq) + Ba2+(aq) + 2 Cl(aq) → BaCO3(s) + 2Na+ (aq) + 2Cl(aq)
CO3 2- (aq) + Ba2+(aq) → BaCO3(s)

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + HOH(\ell)$
$Na^+(aq) + OH(aq) + H^+(aq) + Cl(aq) \rightarrow Na^+(aq) + Cl(aq) + HOH(\ell)$
$OH(aq) + H^+(aq) \rightarrow HOH(\ell)$

$Cu(NO_3)_2(aq) + (NH_4)_2S(aq) \rightarrow CuS(s) + 2NH_4NO_3(aq)$
$Cu^{2+}(aq) + 2NO_3^-(aq) + 2NH_4 + (aq) + S^{2-}(aq) \rightarrow CuS(s) + 2NH_4 + (aq) + 2NO_3^-(aq)$
$Cu^{2+}(aq) + S^{2-}(aq) \rightarrow CuS(s)$